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63/1 (SEM-5) DSE2/PHYHE5026

2023

PHYSICS

Paper : PHYHE5026

(Nuclear and Particle Physics)

Full Marks : 80

Pass Marks : 32

Time : Three hours

The figures in the margin indicate full marks for the questions.

1. Choose the correct answer : **(any six)** 1×6=6
- (a) Which of the following is most stable ?
- (i) Neutron
 - (ii) Proton
 - (iii) Meson
 - (iv) Electron

Contd.

(b) According to Yukawa, the nuclear forces develop by the exchange of

- (i) photon
- (ii) electron
- (iii) positron
- (iv) meson

(c) Nuclear fission is explained by

- (i) collective model
- (ii) shell model
- (iii) liquid drop model
- (iv) fermi gas model

(d) Rutherford is the unit of

- (i) electric field
- (ii) energy
- (iii) magnetic field
- (iv) radioactive activity

(e) The average life time (τ) and the decay constant (λ) are related as

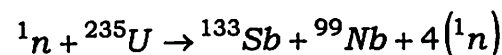
(i)
$$\tau = \frac{\lambda}{0.693}$$

(ii)
$$\tau = \frac{0.693}{\lambda}$$

(iii)
$$\frac{\tau}{\lambda} = 1$$

(iv)
$$\tau\lambda = 1$$

(f) The following reaction is an example of what kind of nuclear reaction ?



- (i) Fission
- (ii) β -decay
- (iii) α -decay
- (iv) Fusion

(g) In an elastic collision the particles do not have to conserve

- (i) Momentum
- (ii) Kinetic energy
- (iii) Mass
- (iv) Rebound after collision

(h) Which of the following accelerators does not accelerate electron ?

- (i) Linear accelerator
- (ii) Betatron
- (iii) Cyclotron
- (iv) Van de Graaff generator

(i) Particles that participate in the strong interaction are called –

- (i) Hadrons
- (ii) Leptons
- (iii) Electrons
- (iv) Neutrinos

(j) Quarks come in how many flavours ?

- (i) 3
- (ii) 6
- (iii) 7
- (iv) 2

2. Answer the following questions : **(any five)**

$$2 \times 5 = 10$$

(a) What is atomic mass unit ? Express atomic mass unit (a.m.u.) in kg.

$$1 + 1 = 2$$

(b) Write down *two* drawbacks of liquid drop model.

(c) Define Half-life and Mean-life of a radioactive nuclei.

(d) Explain briefly 'Nuclear Stability'.

(e) How many α and β particles are emitted in the disintegration of ${}^{232}\text{Th}_{90}$ to the end product ${}^{208}\text{Pb}_{82}$?

(f) What is Q-value of nuclear reaction ? Explain briefly.

(g) Write down *two* advantages of Geiger-Muller counter:

3. Answer the following questions : **(any six)**

$$5 \times 6 = 30$$

(a) What are magic nuclei ? Explain with examples.

$$2 + 3 = 5$$

(b) State the laws of radioactive decay. Explain Geiger-Nuttall law.

$$2 + 3 = 5$$

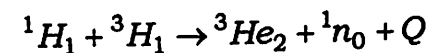
(c) Explain the working of a linear accelerator with diagram.

(d) Explain the Auger effect.

(e) Define nuclear fission and nuclear fusion. How are they alike ? How are they different ?

$$1 + 2 + 2 = 5$$

(f) Find the Q-value of nuclear reaction



Given, $m({}^1\text{H}_1) = 1.007825 \text{ amu}$

$$m({}^3\text{H}_1) = 3.016050 \text{ amu}$$

$$m({}^3\text{He}_2) = 3.016030 \text{ amu}$$

$$m({}^1\text{n}_0) = 1.008665 \text{ amu}$$

$$1 \text{ amu} = 931 \text{ MeV}$$

(g) Discuss attenuation of photons in matter.

(h) What is Bremsstrahlung ? Explain briefly. $1+4=5$

(i) State the principle of Scintillation detector.

(j) Write down *five* differences between a photon and a neutrino.

4. Answer the following questions : **(any two)**
 $10 \times 2 = 20$

(a) Discuss the neutrino hypothesis of β -decay. What is the role of neutrino in β -decay ?

(b) Discuss the theory of Rutherford scattering of α -decay. Also define

(i) Impact parameter

(ii) Distance of closest approach
 $8+1+1=10$

(c) Write about basic functions of radiation detectors. Classify the detectors on the basis of various parameters. $5+5=10$

(d) Explain the working principle of G-M counter. What do you mean by dead time and recovery time of a G-M counter ?
 $8+1+1=10$

5. Answer the following questions : **(any one)**
 $14 \times 1 = 14$

(a) Explain liquid drop model of nucleus. What are the assumptions made in this model ? How does liquid drop model account for nuclear fission ?

$6+4+4=14$

(b) (i) What are leptons ? Name *any three* leptons and their antiparticles. Briefly discuss properties of leptons. $2+3+4=9$

(ii) What are mesons ? Discuss briefly the properties of different kinds of mesons. $1+4=5$

(c) What are the constituents of the nucleus ? Enlist different properties of a nucleus. Explain how to measure the radius of a nucleus. $5+5+4=14$